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Studies in pyrophilous fungi—III.* The viability of the spores of Pyronema

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(WITH PLATE 4)

In the first paper of the present series, in attempting to impress upon botanists the value of *Pyronema* as a plant to be used in regular class study, it was stated that no data were at hand as to the length of time during which the spores of this fungus would keep their viability. As a knowledge of this point is of vital importance in determining whether the teacher is able to tide over this plant in the laboratory from year to year, it is deemed worthy of special study and mention at this time.

As has been previously stated, when once this fungus has been cultivated it is comparatively easy to "get a catch" from the air by simply exposing properly heated soil and keeping it moist for a few days. Especially is this true in greenhouses. To my knowledge, since this fungus has been under observation here, steamed or heated soil used for planting in the propagating houses of the New York Botanical Garden has never failed to develop the fungus. Some time ago the spores of the fungus were sent to Purdue University for experimental purposes, and recently in a conversation with Dr. F. D. Kern he informed me that this fungus also now made its appearance in their greenhouse whenever heated soil was exposed. While the fungus may usually be obtained in this way when once it is started, this method is uncertain and the occurrence of the plant is likely to be delayed when it is most needed. It is therefore better to develop and rely upon some more certain methods of securing and preserving it.

During the present winter the fungus was desired for study in classes at Columbia University, and several pots of heated soil were exposed to the air, as formerly, in the laboratories of the

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* Studies in pyrophilous fungi—II. Changes brought about by the heating of soils and their relation to the growth of *Pyronema* and other fungi, was published in Mycologia **2**: 109–124. *pl. 24–26.* 1910.

New York Botanical Garden. As it had been some time since the fungus had been under cultivation at the Garden, the spores were apparently not very numerous in the air, for after several days the plant failed to appear. Search was then made for some recently collected spores for inoculation. No attempt had been made to keep the spores for this purpose and the youngest specimens available in the herbarium of the Garden had been collected nearly three years before. The soil was inoculated with these aged spores, and within a few days a good growth of *Pyronema* was produced, the infection apparently proceeding from the point of inoculation. As this experiment did not prove with certainty that the old spores germinated, it was decided to test them out in hanging drop culture.

A complete history of the specimen used in the above experiment is as follows. In the spring of 1909, a pile of leaves and brush was burned, and this opportunity was taken to test the growth of *Pyronema* under natural conditions, as the fungus was at that time under cultivation in the laboratory. Spores were taken from the plants grown in the laboratory and with these the burned place was inoculated. In a reasonably short time our burned place showed a good growth of the fungus. One good specimen was collected and placed in the herbarium of the Garden in an ordinary paper packet. In January 1912 the spores from this specimen were used for the experiment described above, and while many of the spores failed to germinate, there was enough growth in a hanging drop culture to form a web of mycelium over the cover glass on which the spores were planted.

The spores of *Pyronema* are rather thin-walled and are not the kind of spores, so far as general appearance is concerned, that would be expected to keep their viability for a long period of time. Also, it would naturally be thought that spores which are adapted to withstand long periods of unfavorable conditions as resting spores would not germinate readily when fresh. The spores of this fungus are an exception in both of these particulars, for the fresh spores germinate very readily in hanging drop culture and very old spores germinate with equal facility; also, the walls of the spores do not appear to be thicker than the walls of the young mycelium and show no protective structures.

The spores germinate by putting out a germ tube from each end, one end, however, growing much faster than the other. The young mycelium is very coarse, the diameters of the main branches being fairly constant. The whole mycelium is filled with vacuoles, giving it a characteristic appearance. The spore before germinating swells much, becoming large and very granular. The germ tube as it issues from the spore is slightly smaller in diameter than the spore but often swells to about the same diameter. The contents of the spore after germination are similar in appearance to the contents of the young mycelium, and there appears to be no difference between the wall of the old spore and that of the young mycelium, the spore forming one segment in the growing mycelium, usually of a little larger diameter and shorter but often so nearly like the other segments of the mycelium that it is difficult to determine the position of the old spore. In some cases the spore seems to swell up and begin to grow by simply cutting off new segments at either end.

The spores of *Pyronema*, as shown in the present experiment, will keep their viability for nearly three years; as to how much longer they will remain good we cannot at present say. Griffiths* in his work on Fimetariaceae (Sordariaceae) found one species in which the spores kept their viability for more than three and one-half years.

The demonstration of the long viability of the spores of *Pyronema* is one more argument in favor of the introduction of this fungus into college and university courses in botany which deal with a general knowledge of the subject. The cultivation of the fungus requires no complicated technique, and the rapidity with which the plant grows would enable the student to study all of the stages from the germinating spore to the production of sex organs and mature ascocarps within a period of about ten days. Also, the asci of *Pyronema* when mounted in water illustrate very nicely the common method of spore dissemination among the ascomycetes.

Claussen† in his recent paper on the development of *Pyronema* states: "Es wirt angegeben dass *Pyronema* auf Brandstellen häufig vorkomme. Häufig kann aber wohl der Pilz nicht sein, da ich ihn bisher nur ein einziges Mal—bei Eberswalde—im Freien fand. So oft ich sonst sowohl bei Freiburg wie bei Berlin solche Stellen absuchte, hatte ich keinen Erfolg."

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* Griffiths, D. The North American Sordariaceae. Mem. Torrey Club **11**: 1–134. *pl. 1–19*. 30 My 1901.

† Claussen, P. Zur Entwicklungsgeschichte der Ascomyceten, *Pyronema confluens*. Zeit. Bot. **4**: 1–80. *pl. 1–6*. 1902.

While nothing can be said here as to the occurrence of the fungus in Europe, the fact remains that it is fairly common in America so far as our knowledge goes. Of course its occurrence in nature depends upon the presence of recently burned areas accompanied by a reasonable amount of precipitation. Given these conditions, and the fungus is common. It has been collected by the writer in Indiana, Iowa, New York, and North Dakota and has been frequently reported by collectors from other states.

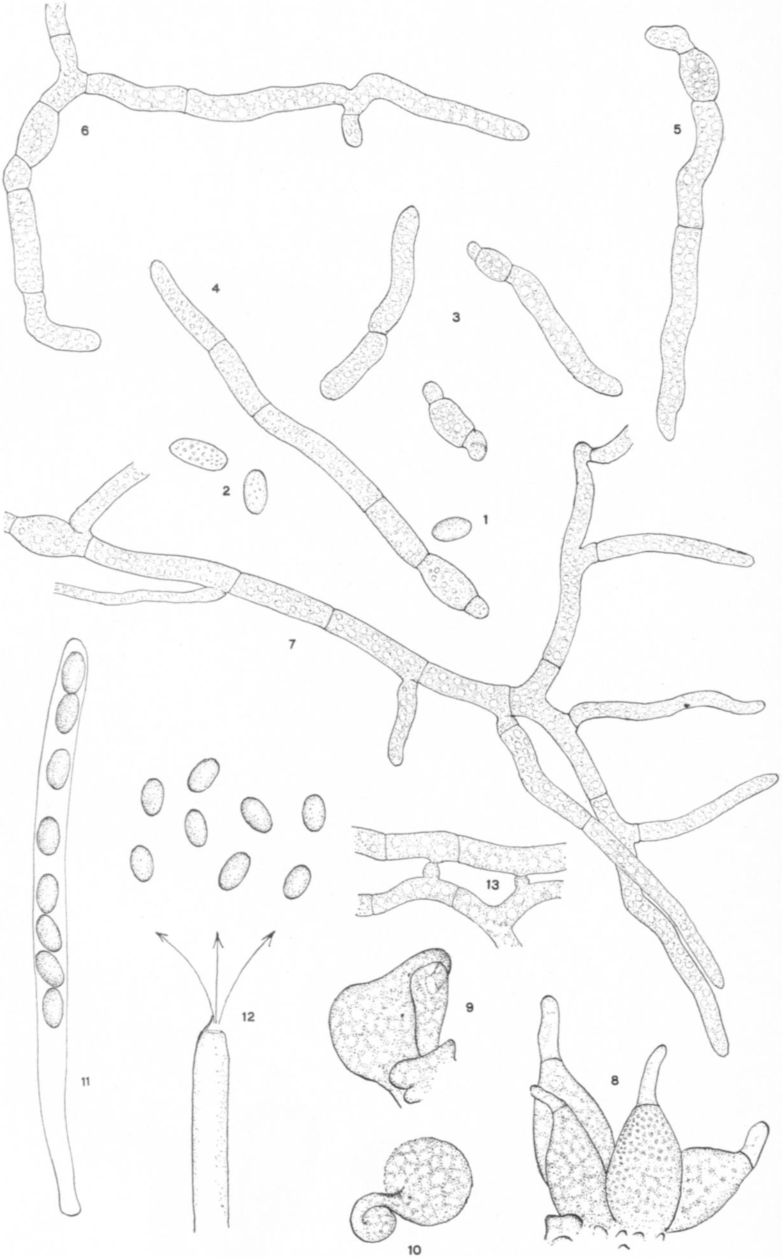
If it should happen that the fungus is not common in a given locality, or as is more likely to be the case, has never been recognized, it has been shown in previous papers that the fungus is easily cultivated in the laboratory; and now having proved the long viability of the spores which enables the plant to be carried over for an indefinite length of time in the laboratory, there is no longer any reason for considering *Pyronema* an uncommon fungus. If the fungus is worth knowing from a morphological point of view it is also worth seeing.

DIRECTIONS FOR CULTIVATION AND PRESERVATION OF THE SPORES

Heat good rich, unfertilized, garden soil by placing it in pots or other receptacle. The heating can be accomplished by steam or dry heat in an autoclave or sterilizing oven. If dry heat is used run the temperature up to 150°–170° C. If neither autoclave nor sterilizing oven is available, bake in an ordinary oven for an hour or more at ordinary baking temperature. Cool and water with tap water. Plant the spores and place the pot under a bell jar. Growth of mycelium should be abundant in two or three days at room temperature; sex organs should appear in about a week and mature ascocarps a few days later.

When through with the study of plants, scrape off the old ascocarps together with a little dirt, place them in an envelope and keep dry until they are desired for study the next year, then prepare substratum and plant as before.

NEW YORK BOTANICAL GARDEN.



SEAVER, ON PYRONEMA

Explanation of plate 4

Pyronema omphalodes

1. Normal ungerminated spore.
2. Spores slightly swollen and apparently about to germinate.
3–7. Stages in the germination of spores on the third morning after planting.
8. Young ascogonia.
9–10. Ascogonia and antheridia, side and end view.
11. Mature ascus.
12. Ascus showing dissemination of spores.
13. Anastomosing mycelium.

All figures are drawn with the camera lucida; 1–7 and 13 show stages in the developing spores collected in the spring of 1909 and germinated January 1912, as they appeared on the third morning after planting.